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ABSTRACT

At the request of the Department of Mathematics at the University of Texas Austin (UT Austin), the Measurement and Evaluation Center conducted a validity study to assist in revising the department's placement policy for Mathematics 403K (M 403K). The existing decision score on the College Board Achievement Test in Mathematics Level 1 (460) was causing unacceptable placement error. Data, including Achievement Test scores and final course grades, were analyzed for 1,337 fall semester students and 781 spring semester students. A recommendation was made that the decision score of 460 be changed to 530. Faculty representatives subsequently lowered the decision score to 480, although students with scores from 480 to 520 were advised that completing an algebra course prior to enrolling in M 403K would probably improve their grades. Eight tables present analysis data. (SLD)

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TWO-SEMESTER VALIDITY STUDY OF THE USE OF THE COLLEGE BOARD ACHIEVEMENT TEST IN MATHEMATICS LEVEL I FOR PLACEMENT INTO M 403K AT UT AUSTIN FALL 1988 and SPRING 1989

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and H. Paul Kelley

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TWO-SEMESTER VALIDITY STUDY OF THE USE OF THE COLLEGE BOARD ACHIEVEMENT TEST IN MATHEMATICS LEVEL I FOR PLACEMENT INTO M 403K AT UT AUSTIN FALL 1988 and SPRING 1989

Lynn M. Trent, Michael J. Barrett, Barbara G. Dodd,
and H. Paul Kelley

At the request of the Department of Mathematics at The University of Texas at Austin, the Measurement and Evaluation Center (MEC) conducted a validity study to assist the department in revising its placement policy for Mathematics 403K (M 403K). For the testing period April 1988 through March 1989, the department had found that its existing decision score of 460 on the College Board Achievement Test in Mathematics Level I was causing unacceptable placement error, shown by the fact that students in M 403K with scores close to 460 were performing poorly.

MEC staff members gathered data from two semesters for students with both Math Level I scores and M 403K final grades. The staff analyzed test scores in relation to student course performance, as measured by final course grade, in order to present to the Department of Mathematics possible placement decision scores.

Method

Subjects

From University records MEC staff members gathered data consisting of both Math Level I scores and M 403K final grades for students enrolled in M 403K for the first time -– 1,337 in the fall semester of 1988 and 781 in the spring semester of 1989. The Mathematics Level I test is used by the department for placing students in its lower division mathematics course sequences. M 403K (*Calculus for Business and Economics*) is the introductory calculus course for the business mathematics sequence. Students lacking sufficient demonstrated competence on the Math Level I test in prerequisite skills for differential and integral calculus must satisfy pre-calculus course prerequisites before registering for M 403K. Therefore students with low scores on the Math Level I test had earned credit for at least one college-level mathematics course prior to enrolling in Math 403K; this additional instruction in mathematics would be expected to reduce the relationship between the Math Level I scores and the final grades in M 403K.

Materials

The Math Level I Test is an achievement test administered six times yearly nationwide by The College Board, and before each registration period and during all summer orientation sessions on the UT Austin campus by the MEC. The Math Level I Test consists of 50 multiple-choice items sampling topics including algebra, plane Euclidian geometry, trigonometry, functional notation, and mathematical reasoning. Scores are reported in increments of 10 using The College Board's 200-800 scale.

Procedure

After obtaining test score and final course grade data from University records, MEC staff members analyzed the relationship between test score and final course grade to obtain test score mean and standard deviation, final course grade mean and standard deviation, and the coefficient of correlation between test scores and course grades. Frequency distributions of the test scores (200-800 scale) were crosstabulated with final course grades (0-4 scale), and regression equations were obtained by which to estimate expected test scores from final grades, and expected final grades from test scores. Additional analyses were performed to estimate for each test score value the accuracy of placement to be expected if that value were to be used as a decision score. A table of possible decision scores was prepared for departmental consideration.

Results

MEC staff members prepared Tables 1.1-1.4 and 2.1-2.4 to present the results of the validity studies to faculty members in the Department of Mathematics. The first set of tables is based upon the 1,377 matching sets of test scores and final grades from the 1988 fall semester, and the second set of tables is based upon the 781 matching sets of test scores and final grades from the 1989 spring semester.

Fall 1988 Study

Table 1.1 shows the frequency distribution of test scores (left column) crosstabulated with the five course grade levels *F* through *A* (0 through 4, columns 3-7) and with the total group of 1,337 students (right column). Across the bottom of the table are (a) the number and percentage of students in each grade level and in the total group, and (b) the test score mean and standard deviation for each grade level and for the total group. To the right are the final course grade mean (2.11) and standard deviation (1.32) for the entire group, the coefficient of correlation between test scores and final course grades (.42), and two regression equations for estimating expected grades and expected scores .

Table 1.1

Scores on The College Board Achievement Test in Mathematics Level I in Relation To Student Performance in Mathematics 403K: Frequency Distributions, Descriptive Statistics, Regression Equations, Expected Grades, and Expected Scores
Fall 1988
(N = 1,337)

		Final Grades in Mathematics 403K					
Test Scores	Expected Grades	0 F	1 D	2 C	3 B	4 A	Total N
580-800	2.39-4.00	36	32	91	146	151	456
560-579	2.24-2.38	18	15	40	37	27	137
550	2.16	14	10	23	28	16	91
540	2.08	7	9	13	14	1	44
530	2.01	8	7	13	11	10	49
520	1.93	23	13	14	19	8	77
510	1.85	15	11	29	21	3	79
500	1.77	10	6	16	14	2	48
490	1.70	16	12	25	8	1	62
480	1.62	10	15	14	11	2	52
470	1.54	22	20	12	8	2	64
460	1.47	15	14	21	5	3	58
400-459	1.00-1.46	29	27	32	9	2	99
200-399	0.00-1.00	2	7	7	5	0	21
Total		225	198	350	336	228	1,337
%		17%	15%	26%	25%	17%	100%
Mean Score		513.24	508.59	530.23	563.45	599.82	544.38
Standard Deviation		59.14	65.73	66.45	66.63	60.90	71.71
Expected Score		497	519	542	565	587	

Expected Grade = (Test Score x 0.0077) - 2.0754

Expected Score = (Preliminary Grade x 22.6514) + 496.6405

Mean Grade	Standard Deviation
2.11	1.32

Coefficient of Correlation
r = .42

Table 1.2

Scores on The College Board Achievement Test in Mathematics Level I in Relation To Student Performance in Mathematics 403K: Combined Frequency Distributions and Descriptive Statistics
Fall 1988
(N = 1,337)

	Final Grades in M 403K		
Test Scores	Unsatisfactory 0,1	Satisfactory 2-4	Total N
580-800	68	388	456
560-579	33	104	137
550	24	67	91
540	16	28	44
530	15	34	49
520	36	41	77
510	26	53	79
500	16	32	48
490	28	34	62
480	25	27	52
470	42	22	64
460	29	29	58
400-459	56	43	99
200-399	9	12	21
Total	423	914	1,337
%	32%	68%	100%
Mean Score	511.06	559.80	544.38
Standard Deviation	62.28	70.56	71.71

Mean Grade	Standard Deviation
2.11	1.32

Coefficient of Correlation
r = .42

Table 1.3

Scores on the College Board Achievement Test in Mathematics Level I in Relation to Student Performance in Mathematics 403K: Possible Decision Scores and Corresponding Accuracies of Placement
Fall 1988
(N = 1,337)

Place-ment Category	Cumulative Number of Students				Percent of Students in Each Placement Category			Overall Accuracy of Placement		
	Unsatisfactory 0,1 (N = 423)		Satisfactory 2-4 (N = 914)		Unsatisfactory		Satisfactory	Placement Accuracy	Number of Students	% of Students
560 - up	Too High	101	492	Correct	Too High	24%	54% Correct	Too High	101	8%
								Correct	814	61%
Below 560	Correct	322	422	Too Low	Correct	76%	46% Too Low	Too Low	422	32%
550 - up	Too High	125	559	Correct	Too High	30%	61% Correct	Too High	125	9%
								Correct	857	64%
Below 550	Correct	298	355	Too Low	Correct	70%	39% Too Low	Too Low	355	27%
540 - up	Too High	141	587	Correct	Too High	33%	64% Correct	Too High	141	11%
								Correct	869	65%
Below 540	Correct	282	327	Too Low	Correct	67%	36% Too Low	Too Low	327	24%
530 - up	Too High	156	621	Correct	Too High	37%	68% Correct	Too High	156	12%
								Correct	888	66%
Below 530	Correct	267	293	Too Low	Correct	63%	32% Too Low	Too Low	293	22%
520 - up	Too High	192	662	Correct	Too High	45%	72% Correct	Too High	192	14%
								Correct	893	67%
Below 520	Correct	231	252	Too Low	Correct	55%	28% Too Low	Too Low	252	19%
510 - up	Too High	218	715	Correct	Too High	52%	78% Correct	Too High	218	16%
								Correct	920	69%
Below 510	Correct	205	199	Too Low	Correct	48%	22% Too Low	Too Low	199	15%
500 - up	Too High	234	747	Correct	Too High	55%	82% Correct	Too High	234	18%
								Correct	936	70%
Below 500	Correct	189	167	Too Low	Correct	45%	18% Too Low	Too Low	167	12%
490 - up	Too High	262	781	Correct	Too High	62%	85% Correct	Too High	262	20%
								Correct	942	70%
Below 490	Correct	161	133	Too Low	Correct	38%	15% Too Low	Too Low	133	10%
480 - up	Too High	287	808	Correct	Too High	68%	88% Correct	Too High	287	21%
								Correct	944	71%
Below 480	Correct	136	106	Too Low	Correct	32%	12% Too Low	Too Low	106	8%
470 - up	Too High	329	830	Correct	Too High	78%	91% Correct	Too High	329	25%
								Correct	924	69%
Below 470	Correct	94	84	Too Low	Correct	22%	9% Too Low	Too Low	84	6%
460 - up	Too High	358	859	Correct	Too High	85%	94% Correct	Too High	358	27%
								Correct	924	69%
Below 460	Correct	65	55	Too Low	Correct	15%	6% Too Low	Too Low	55	4%

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Table 1.4

Scores on The College Board Achievement Test in Mathematics Level I in Relation to Student Performance in Mathematics 403K: Scores Suggested by Six Guidelines for Use in Selecting Decision Scores
Fall 1988
(N = 1,337)

Guideline	Mathematics Level I Score
1. Expected Score for students whose performance in course was just minimally satisfactory (i.e., students with preliminary grades of *C*; see Expected Score row at bottom of Table 1.1).	542
2. Score for which Expected Grade was just minimally satisfactory (i.e., *C*; see Expected Grade column in Table 1.1).	530
3. Score for which percents of errors of students in each academic performance category (Unsatisfactory, Satisfactory) were most nearly equal. (See % Too High and % Too Low values in middle columns of Table 1.3.)	540
4. Score for which overall percents of errors were most nearly equal. (See % Too High and % Too Low values in last column of Table 1.3.)	510
5. Score that would have cut off (or held back) approximately the same number of students as were in the Unsatisfactory performance group. (See Table 1.2 for number of students in the Unsatisfactory group and the test score that most nearly identifies that number of low-scoring students.)	510
6. Score that would have maximized overall accuracy of placement. (See number Correct in next-to-last column of Table 1.3.)	480

Table 1.1 also presents values for two variables estimated using the two regression equations shown: the Expected Grade (column 2) for each test score, and the Expected Score (bottom row) for each grade level. These data may be used, for example, to determine that the minimally satisfactory grade of *C* (2.00) is expected for the group of students with the test score of 530, or that for students achieving a final grade of *C*, the expected test score is 542.

Table 1.2 collapses the five grade levels of Table 1.1 into two performance levels: Unsatisfactory (grades *F* and *D*, or 0 and 1), and Satisfactory (grades *C*, *B*, and *A*, or 2, 3, and 4). Across the bottom of Table 1.2 appear the number and percentage of students in each performance category, and the test score mean and standard deviation for each level.

Table 1.3 presents the expected placement accuracies for 11 possible decision scores. In the left column are placement categories (possible decision scores). Two pairs of columns to the right present, respectively, the cumulative number and percentage of students in each academic performance category (Unsatisfactory and Satisfactory) who would be placed correctly and incorrectly using each of the possible decision scores. Incorrect placement for students in the Unsatisfactory category means being placed "Too High," while incorrect placement for students in the Satisfactory category means being placed "Too Low." The final three columns present the overall accuracy of placement ("Too High," "Correct," and "Too Low") by number and percentage for the two academic categories combined.

Table 1.4 lists six guidelines suggested by various authorities for selecting decision scores to be used for course placement and awarding of credit by examination. Each guideline refers the reader to one of the preceding tables. Based on this validity study, possible decision scores justified by the six guidelines range from a low of 480 to a high of 542.

Spring 1989 Study

Table 2.1 shows the frequency distribution of test scores (left column) crosstabulated with the five course grade levels *F* through *A* (0 through 4, columns 3-7) and with the total group of 781 students (right column). Across the bottom of the table are (a) the number and percentage of students in each grade level and in the total group, and (b) the test score mean and standard deviation for each grade level and for the total group. To the right are the final course grade mean (2.07) and standard deviation (1.41) for the entire group, the coefficient of correlation between test scores and

Table 2.1

Scores on The College Board Achievement Test in Mathematics Level I in Relation To Student Performance in Mathematics 403K: Frequency Distributions, Descriptive Statistics, Regression Equations, Expected Grades, and Expected Scores
Spring 1989
(N = 781)

		Final Grades in Mathematics 403K					
Test Scores	Expected Grades	0 F	1 D	2 C	3 B	4 A	Total N
580-800	2.31-3.50	32	17	43	46	86	224
560-579	2.21-2.31	23	9	10	25	17	84
550	2.15	6	8	12	6	9	41
540	2.10	1	12	8	4	11	36
530	2.04	15	7	8	7	7	44
520	1.99	7	7	11	9	2	36
510	1.94	14	8	15	6	7	50
500	1.88	9	5	9	12	3	38
490	1.83	10	6	18	6	4	44
480	1.77	6	6	11	10	1	34
470	1.72	8	5	13	6	4	36
460	1.67	18	8	13	6	6	51
400-459	1.34-166	9	13	13	20	3	58
200-399	0.26-1.34	3	0	0	1	1	5
Total		161	111	184	164	161	781
%		21%	14%	24%	21%	21%	100%
Mean Score		523.35	522.25	527.77	534.09	578.94	537.95
Standard Deviation		61.63	60.93	62.53	67.28	67.10	67.40
Expected Score		513	525	537	549	562	

Expected Grade = (Test Score x 0.0054) - .8179

Expected Score = (Preliminary Grade x 12.1897) + 512.7448

Mean Grade	Standard Deviation
2.07	1.41

Coefficient of Correlation
r = .26

Table 2.2

Scores on The College Board Achievement Test in Mathematics Level I in Relation To Student Performance in Mathematics 403K: Combined Frequency Distributions and Descriptive Statistics
Spring 1989
(N = 781)

	Final Grades in M 403K		
Test Scores	Unsatisfactory 0,1	Satisfactory 2-4	Total N
580-800	49	175	224
560-579	32	52	84
550	14	27	41
540	13	23	36
530	22	22	44
520	14	22	36
510	22	28	50
500	14	24	38
490	16	28	44
480	12	22	34
470	13	23	36
460	26	25	51
400-459	22	36	58
200-399	3	2	5
Total	272	509	781
%	35%	65%	100%
Mean Score	522.90	545.99	537.95
Standard Deviation	61.24	69.20	67.40

Mean Grade	Standard Deviation
2.07	1.41

Coefficient of Correlation
r = .26

Table 2.3

Scores on the College Board Achievement Test in Mathematics Level I in Relation to Student Performance in Mathematics 403K: Possible Decision Scores and Corresponding Accuracies of Placement
Spring 1989
(N = 781)

Placement Category	Cumulative Number of Students				Percent of Students in Each Placement Category			Overall Accuracy of Placement		
	Unsatisfactory 0,1 (N = 272)		Satisfactory 2-4 (N = 509)		Unsatisfactory		Satisfactory	Placement Accuracy	Number of Students	% of Students
560 - up	Too High	81	227	Correct	Too High	30%	45% Correct	Too High	81	10%
								Correct	418	54%
Below 560	Correct	191	282	Too Low	Correct	70%	55% Too Low	Too Low	282	36%
550 - up	Too High	95	254	Correct	Too High	35%	50% Correct	Too High	95	12%
								Correct	431	55%
Below 550	Correct	177	255	Too Low	Correct	65%	50% Too Low	Too Low	255	33%
540 - up	Too High	108	277	Correct	Too High	40%	54% Correct	Too High	108	14%
								Correct	441	56%
Below 540	Correct	164	232	Too Low	Correct	60%	46% Too Low	Too Low	232	30%
530 - up	Too High	130	299	Correct	Too High	48%	59% Correct	Too High	130	17%
								Correct	441	56%
Below 530	Correct	142	210	Too Low	Correct	52%	41% Too Low	Too Low	210	27%
520 - up	Too High	144	321	Correct	Too High	53%	63% Correct	Too High	144	18%
								Correct	449	57%
Below 520	Correct	128	188	Too Low	Correct	47%	37% Too Low	Too Low	188	24%
510 - up	Too High	166	349	Correct	Too High	61%	69% Correct	Too High	166	21%
								Correct	455	58%
Below 510	Correct	106	160	Too Low	Correct	39%	31% Too Low	Too Low	160	20%
500 - up	Too High	180	373	Correct	Too High	66%	73% Correct	Too High	180	23%
								Correct	465	60%
Below 500	Correct	92	136	Too Low	Correct	34%	27% Too Low	Too Low	136	17%
490 - up	Too High	196	401	Correct	Too High	72%	79% Correct	Too High	196	25%
								Correct	477	61%
Below 490	Correct	76	108	Too Low	Correct	28%	21% Too Low	Too Low	108	14%
480 - up	Too High	208	423	Correct	Too High	76%	83% Correct	Too High	208	27%
								Correct	487	62%
Below 480	Correct	64	86	Too Low	Correct	24%	17% Too Low	Too Low	86	11%
470 - up	Too High	221	446	Correct	Too High	81%	88% Correct	Too High	221	28%
								Correct	497	64%
Below 470	Correct	51	63	Too Low	Correct	19%	12% Too Low	Too Low	63	8%
460 - up	Too High	247	471	Correct	Too High	91%	93% Correct	Too High	247	32%
								Correct	496	64%
Below 460	Correct	25	38	Too Low	Correct	9%	7% Too Low	Too Low	38	5%

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Table 2.4

Scores on The College Board Achievement Test in Mathematics Level I in Relation to Student Performance in Mathematics 403K: Scores Suggested by Six Guidelines for Use in Selecting Decision Scores
Spring 1989
(N = 781)

Guideline	Mathematics Level I Score
1. Expected Score for students whose performance in course was just minimally satisfactory (i.e., students with preliminary grades of *C*; see Expected Score row at bottom of Table 2.1).	537
2. Score for which Expected Grade was just minimally satisfactory (i.e., *C*; see Expected Grade column in Table 2.1).	530
3. Score for which percents of errors of students in each academic performance category (Unsatisfactory, Satisfactory) were most nearly equal. (See % Too High and % Too Low values in middle columns of Table 2.3.)	540
4. Score for which overall percents of errors were most nearly equal. (See % Too High and % Too Low values in last column of Table 2.3.)	510
5. Score that would have cut off (or held back) approximately the same number of students as were in the Unsatisfactory performance group. (See Table 2.2 for number of students in the Unsatisfactory group and the test score that most nearly identifies that number of low-scoring students.)	510
6. Score that would have maximized overall accuracy of placement. (See number Correct in next-to-last column of Table 2.3.)	470

final course grades (.26), and two regression equations for estimating expected grades and expected scores.

Table 2.1 also presents values for two variables estimated using the two regression equations shown: the Expected Grade (column 2) for each test score, and the Expected Score (bottom row) for each grade level. These data may be used, for example, to determine that the minimally satisfactory grade of *C* (2.00) is expected for the group of students with the test score of 530, or that for students achieving a final grade of *C*, the expected test score is 537.

Table 2.2 collapses the five grade levels of Table 2.1 into two performance levels: Unsatisfactory (grades *F* and *D*, or 0 and 1), and Satisfactory (grades *C*, *B*, and *A*, or 2, 3, and 4). Across the bottom of Table 2.2 appear the number and percentage of students in each performance category, and the test score mean and standard deviation for each level.

Table 2.3 presents the expected placement accuracies for 11 possible decision scores. In the left column are placement categories (possible decision scores). Two pairs of columns to the right present, respectively, the cumulative number and percentage of students in each academic performance category (Unsatisfactory and Satisfactory) who would be placed correctly and incorrectly using each of the possible decision scores. Incorrect placement for students in the Unsatisfactory category means being placed "Too High," while incorrect placement for students in the Satisfactory category means being placed "Too Low." The final three columns present the overall accuracy of placement ("Too High," "Correct," and "Too Low") by number and percentage for the two academic categories combined.

Table 2.4 lists six guidelines suggested by various authorities for selecting decision scores to be used for course placement and awarding of credit by examination. Each guideline refers the reader to one of the preceding tables. Based on this validity study, possible decision scores justified by the six guidelines range from a low of 470 to a high of 540.

Discussion and Decision Making

During a January 1990 meeting with the Department of Mathematics faculty, MEC staff members recommended changing the then-current decision score of 460 to 530, which was the score for which the Expected Grade was just minimally satisfactory (see Guideline 2 in Tables 1.4 and 2.4). The department faculty representatives felt a decision score of 530 would result in too many students being placed in a course which might not be useful to them; consequently, the faculty representatives chose 480 as the new decision score. Students with Math Level I scores between 480 and 520,

however, would be told that data suggest that completing M 301 (*College Algebra*) prior to enrolling in M 403K probably will improve their grades in M 403K. The department subsequently approved a placement plan based on four Math Level I score ranges:

Range	Placement Decision
200-399	"Low Score": consult advisor
400-479	Must take M 301 before taking M 403K
480-579	May take M 403K, but data show that those with scores between 480-520 probably will improve their grades by taking M 301 first
580-800	May take M 403K, but consult with advisor concerning alternatives

The placement plan was implemented beginning with the April 1990 testing period.